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Forces between reactive surfaces

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Adhesive and repulsive, nm-range surface forces acting between mineral grains control colloidal stability and mineral aggregation but less is known about how these forces are affected by surface reactivity and to what extent these grain-scale forces can influence various deformation processes in rocks. In this experimental work, we explore and quantify the surface forces acting between dynamic mineral surfaces that undergo recrystallization or are chemically reactive in contact with water or aqueous salt solutions. Our experimental setup consists of the surface forces apparatus (SFA) coupled with the multiple beam interferometry (MBI). This setup can excellently reproduce a typical grain contact geometry with nanometer-thin water films confined between contacting mineral grains over relatively large, micron-sized contact areas. Owing to the use of MBI, both surface growth or dissolution processes can be monitored during force measurements in real-time. As such, SFA can provide information about the links between surface reactivity and adhesive or repulsive surface forces. Using the examples of force measurements between recrystallizing or chemically reactive mineral surfaces such as carbonates, hydroxides, and silicates, we comment on the relationship between the measured surface forces and surface reactivity. We link our findings with the observed changes in mineral phases, surface topographies, or surface roughness. We also comment on how the micron-scale confinement in the SFA affects the growth and dissolution processes in contrast to less confined regions. The magnitude of the forces associated with dynamic mineral surfaces and the potential significance of these forces to macroscopic deformation processes and cohesion in rocks are discussed.